Interruptions in Workflow for RNs in a Level One Trauma Center

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ABSTRACT

An understanding of interruptions in healthcare is important for the design, implementation, and evaluation of health information systems and for the management of clinical workflow and medical errors. The purpose of this study is to identify and classify the types of interruptions experienced by Emergency Department(ED) nurses working in a Level One Trauma Center. This was an observational field study of Registered Nurses (RNs) employed in a Level One Trauma Center using the shadowing method. Results of the study indicate that nurses were both recipients and initiators of interruptions. Telephones, pagers, and face-to-face conversations were the most common sources of interruptions. Unlike other industries, the healthcare community has not systematically studied interruptions in clinical settings to determine and weigh the necessity of the interruption against their sometimes negative results such as medical errors, decreased efficiency, and increased costs. Our study presented here is an initial step to understand the nature, causes, and effects of interruptions, thereby improving both the quality of healthcare and patient safety. We developed an ethnographic data collection technique and a data coding method for the capturing and analysis of interruptions. The interruption data we collected are systematic, comprehensive, and close to exhaustive. They confirmed the findings from earlier studies by other researchers that interruptions are frequent events in critical care and other healthcare settings. We are currently using these data to analyze the workflow dynamics of ED clinicians, to identify the bottlenecks of information flow, and to develop interventions to improve the efficiency of emergency care through the management of interruptions.

INTRODUCTION

Health informatics recognizes that user-centered design of health information systems and medical devices reduces medical errors. In turn, an understanding of the clinical setting using a user-centered approach would be useful in determining how human factors such as interruptions contribute to medical error. New technology can introduce more interruptions (e.g., alerts and reminders) as well as reduce interruptions (e.g., automation). An understanding of the causes and consequences of interruption in healthcare is important for the design, implementation, and evaluation of health information systems and for the management of clinical workflow and medical errors.

Patient safety organizations such as The Joint Commission for the Accreditation Organization (JCAHO)[1, 2] and the United States Pharmacopeia through MEDMARX acknowledge that interruptions contribute to preventable medical errors. Analysis of medication error reports submitted to MEDMARX indicates that hospitals attribute 43% of medication errors to workplace distractions[3, 4]. In a Sentinel Event Alert, JCAHO recognizes that distraction factors contributed to wrong site surgery errors[2]. A recent report from Morbidity and Mortality Weekly Review (MMWR) shows how an environment full of multi-tasking and interruptions contributed to a nurse making a medication error. The following excerpt describes the event "... *As she (nurse) was about to telephone the pharmacy for clarification, a physician demanding her immediate assistance with another patient distracted her. Several minutes later, when she re-entered the room of the leukemia patient, she forgot what she had been planning to do before the interruption and simply hung the medication The nurse had been "yelled at" the day before by another physician—she attributed her immediate and total diversion of attention in large part to her fear of a similar episode ...* "[5]. However, these reports do not provide detailed information about the clinical environment where the interruptions occur. A review of current literature found revealed few studies that examined how the number of interruptions influences nurses working in various clinical settings[6-10]. Therefore, a study is needed that identifies the types of tasks nurses are performing when receiving an interruption, the interrupting tasks, and the impact of interruptions on workflow, efficiency, and productivity. The purpose of this study is to identify and classify the types of interruptions experienced by ED nurses working in a Level One Trauma Center. The dynamics of the environment of the ED provides an ideal setting for studying interruptions.

Healthcare settings, especially nursing settings, have been described as an environment full of interruptions and multi-tasking[11], where work is interruptive[6] and performance is inefficient[9]. This environment, in conjunction with professional roles and responsibilities, may influence the number of interruptions that a clinician experiences. For example, nurses who performed tasks that were previously assigned to physicians in primary clinics experienced a decrease in the number of interruptions they received[9]. Finding from studies in hospitals indicate that professional titles and responsibilities influence the number of interruptions received and generated. Lower ranking individuals commonly receive more interruptions. Coiera and Tombs contend that doctors working in the hospital as house staff officers were interrupted more often than those in higher-ranking positions such as consultants[6]. In contrast, Spencer and Logan found that both interruption rates were higher for positions of authority for ED clinicians. Senior physicians and the RN managers received 23.5 and 24.9 interruptions per hour, respectively. Conversely, staff RNs and junior physicians were interrupted at a rate of 9.2 and 8.3 per hour, respectively[10]. The conflicting results point out that it is unclear how role and status influence the number of interruptions a clinician receives. Specifically, nurses and doctors working in the same departments such as the Emergency Department (ED)[7] and Post- Anesthesia Care Unit (PACU)[8] expect to be interrupted by the unscheduled arrival of patients and the coordination of different clinical specialty services for each patient. Contacting the various clinical specialists relies on the use of synchronous communication channels such as the telephone. In the follow-up to an earlier study, Coiera, Jayasuriya, Hardy, Bannan, and Thorpe studied communication patterns for doctors (n=6) and nurses (n=6) in two EDs. Results indicated that collectively, doctors and nurses received 11.15 interruptions per hour. As separate groups, doctors and nurses had similar rates of interruptions occurring at a rate of 11.1 (95% CI, 9.7-12.7) and 11.2 (95% CI, 9.5-12.7), respectively. A related study of ED nurses and doctors, shows a slightly higher overall rate of interruption for doctors and nurses with a rate of 14.8 interruptions per hour[10].

Clinical care depends on communications between nurses and doctors and other providers. Clinicians do not consider making a phone call or stopping a colleague in the hall as an interruption. Little regard is given for what effects the telephone call interruption has on the recipient because higher priority is given to completion of a personal task[6]. Unplanned communication such as face-to-face and telephone calls can be considered an interruption by the recipient. Coiera and Tombs argue that clinicians' preference for synchronous communication contributed to an interruptive work environment. Results indicated that doctors and nurses initiated about twice (65) as many calls as they received (31) involving either the telephone or paging. Specifically, the nurses initiated 22 calls while being the recipient of 8 calls[6].

The literature review provides evidence that researchers have begun to study interruptions that nurses and doctors encounter in the clinical setting. The studies indicate that nurses and doctors working in either an ambulatory care setting or in hospitals are frequently interrupted. However, these studies provide little information about the nature of the interruption and the impact on workflow, efficiency, and productivity.

METHODS
Study design This was an observational field study using the shadowing method. Shadowing is a qualitative technique that does not necessarily involve the use of statistical analysis of data. In shadowing, observers follow the subjects unobtrusively and take notes of what, why, and how the subjects perform their routine tasks in real world settings.

Participants A convenience sample of six female and two male Registered Nurses with at least six months' experience in the ED were asked to participate. Participation was voluntary and written consent was obtained prior to an observation session. The observations were made during October 2004 with each session lasting a minimum of two hours but not exceeding twelve hours. The subjects had to be at least 21 years of age to participate.

Ethical approval Approval was obtained from institutional ethic committees prior to initiating the study.

Setting All observations were made in the trauma section of the ED of a large teaching hospital. The hospital is situated in a major medical center in the Gulf Coast region of the US. The organization is certified as a Level 1 Trauma Center, providing 24-hour emergency and trauma care to approximately 52,000 patients a year. The ED occupies 51,000 square feet and contains major trauma and cardiac resuscitation rooms.

Data Collection Observers typically worked in teams of two and they recorded observations using a semi-structured field note implemented on Tablet PCs. Subjects were shadowed for a minimum of 2 hours but did not exceed 12 hours. Recording of observations commenced once informed consent was given by the participant. Observations were recorded on a semi-structured field note in one-minute increments. Observations included time commenced, task initiated, location, description of the task including person(s) involved and tools used. Observers synchronized their stopwatches before the start of a session to assure accuracy in recording events.

Data Analysis Each time-stamped observation was transcribed and entered into an Excel spreadsheet. Analysis of observations relied on using constant comparison as a strategy to identify categories of interruptions[12]. Two coders analyzed the data for agreement of tasks and interruptions. A percent agreement score was calculated. The data in Excel spreadsheet were entered into MacShapa for further analysis of the temporal data. MacShapa is a Macintosh-based qualitative data analysis software application for sequential data.

RESULTS

Observers The observers typically worked in teams of two. Observer 1 is an RN with 26 years' experience in healthcare and is competent in human factors. Observer 2 is also a human factors expert with 6 years' experience but has had no training as a healthcare professional. Two observers were used to maximize the capture of interruptions in the fast-paced environment.

Demographics Eight nurses were shadowed for a total of 40 hours 9 minutes. Observations were made on either the 7a – 3p or 3p – 11p shift. The shifts were selected because of high activity and recommendations from a domain expert in Emergency Medicine. The charge nurse for the shift pre-selected the RN for the observation based on consent of the subject.

Interruptions An understanding of interruption can only be made within the context of work and the number of tasks performed. Each observer recorded the tasks observed in a semi-structured field note. All observations were transcribed into an Excel spreadsheet. Observer 1 analyzed each time-stamped cell to identify an interruption. The coded spreadsheet was sent to Observer 2 for verification and further identification of interruptions. The two coders met to resolve any disagreement in coding. If an agreement could be reached, the observation in question was resolved. If no resolution could be reached, the observation was left unresolved. A percent agreement was calculated. Analysis of the data indicates a 63.15% agreement for observations identified as interruptions by Observer 1. A similar agreement of 62.16 % was obtained for Observer 2 data.

Table 1 shows a summary of the number of tasks and interruptions recorded. Observer 1 recorded more interruptions than Observer 2. This could be attributed to two observation sessions that were conducted with only one observer. Two observers were planned for each observation in order to maximize the capture of data and attempt to reach agreement of data between observers. Based on our experience in this study, one trained observer could accurately identify and record the observations.

Table 1. A Summary of Tasks and Interruptions

Subject	Total # of Tasks Recorded by Observer 1	Total # of Interruptions Recorded by Observer 1	% Tasks Interrupted	Total # of Tasks Recorded by Observer 2	Total # of Interruptions Recorded by Observer 2	% Tasks Interrupted
A	265	22	8.3	149	15	10.1
B	218	12	5.5	116	15	12.9
C	426	17	3.9	*	*	*
D	430	21	4.8	*	*	*
E	376	19	5.1	206	13	6.3
F	265	19	7.2	161	10	6.2
G	170	22	12.9	125	21	16.8
H	132	27	20.5	86	26	30.2
Total	2282	159	6.9	843	100	11.9

* A second observer was not on site

Analysis of the observations indicates that Observer 1 found that 6.96% tasks were interrupted, whereas Observer 2 found 11.86%. This could be attributed to the smaller number of tasks observed and may be attributed to Observer 2 not having a healthcare background. This suggests that Observer 2 was keenly focused on recording interruptions more than on recording tasks.

All identified interruptions were entered into a MacShapa spreadsheet for additional coding. Each interruption was time-stamped and coded. The entry was coded for the initiator of the interruption, the recipient, handling, details of the event, location, and patient.

A timeline was run for each session to graphically depict in time when an interruption occurred and the type. This illustrated in the in the following example.
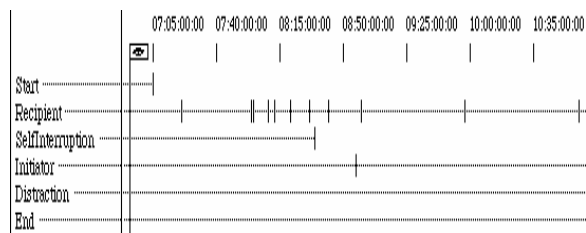

Figure 1. A timeline of interruption occurrence

The timeline shows the various types of interruptions. The timelines were used to compare agreement of time and type of interruption recorded by Observer 1 and Observer 2.

All observations were analyzed for the individual clinician. Results are presented as summaries. Observations recorded by Observer 1 were analyzed over several iterations as the coder became more sensitive to the subtleties in the presentation of interruptions. This was most pronounced in the identification of interruptions in communication encounters. Results of the first and final analysis of the observations are presented in Figures 1 and 2.
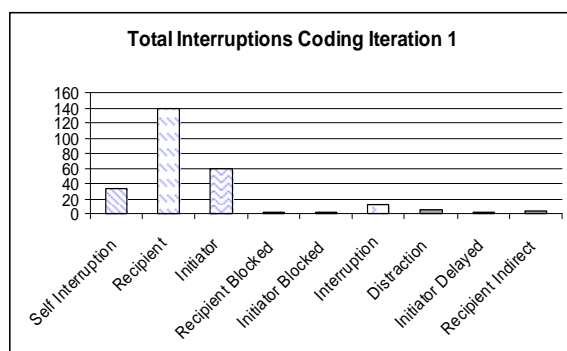

Figure 1. Interruptions: Coding iteration 1

Sensitivity to the observations increased and new categories of interruptions emerged. The coding was supported by additional analysis in MacShapa. The reanalysis found that organizational design of the Trauma ED contributed to interruptions in workflow. The centralization of medication and supplies contribute to interruption in workflow. When the resources are not kept in the trauma cubicle the nurse must leave the workspace to retrieve the item. Medications are stored in a secured centralized location within the Trauma Department but each time the RN medicates a patient the nurse must break in task to retrieve the medication from this location. Each time a patient needs a warm blanket the nurse must leave the bedside to retrieve the blanket. In order to take a patient's temperature the nurse must locate the thermometer because an individual device is not kept at the bedside, again causing the nurse to leave the patient. In other situations workflow is interrupted as the RN leaves the immediate work area of the ED to deliver laboratory specimens to the Stat Laboratory. The Stat Laboratory is located in the Medicine Section of the ED. The nurse also leaves the Trauma Section for the Medicine Section to retrieve medications not stocked in trauma and to send a fax. The closest fax machine is located in the Medicine Section. This shows that the RN must stop care at the bedside to get supplies not kept at the bedside. The frequency of the new interruptions is shown in Figure 2.
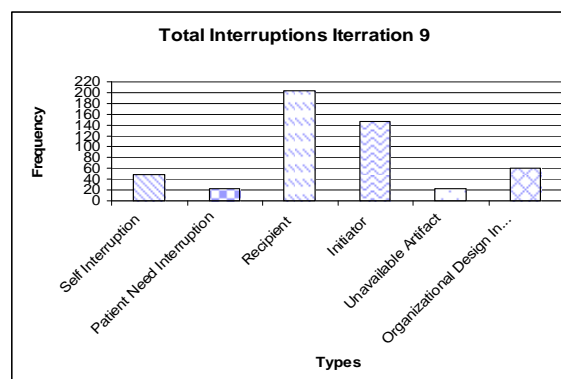

Figure 2. Interruptions: Coding iteration 9

The final iteration of analysis was used to compare the mediums of interruption with environmental and organizational interruptions. The comparison is shown in Figure 3.
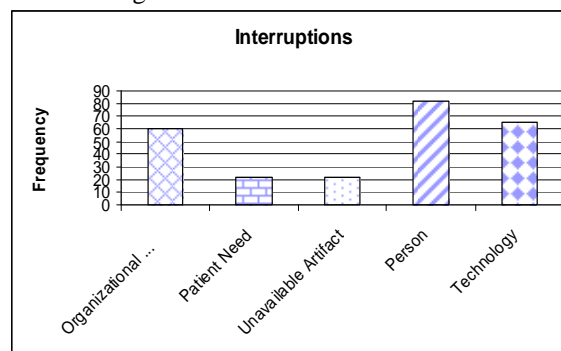

Figure 3. Interruptions by environment and source

As shown, the recipient of an interruption most often received the interruption through another person such as face-to-face encounters. The technology category included both pager and telephone interruptions. These findings may be attributed to the close proximity in which the clinicians work with each other and the need to communicate. Results of this study indicate that environmental design contribute to interruptions at a frequency similar to interruptions initiated by another person.

Conclusion

Interruptions can not only decrease performance but can also cause human errors that sometimes lead to catastrophic events. Unlike other industries, the outcomes caused by interruptions resulting in medical errors, decreased efficiency, and increased cost have not been systematically studied in healthcare. Our study presented here is an initial step to understand the nature, causes, and effects of interruptions, and to develop interventions with which to manage interruptions to improve healthcare quality and patient safety. We selected the ED as our study domain because ED is a high workload, information intensive, time sensitive, interruption-laden, and life-critical environment. Managing interruptions to reduce medical errors and increase efficiency in such an environment is of paramount importance for patient safety and healthcare quality. We developed an ethnographic data collection technique and a data coding method for the capturing and analysis of interruptions. The interruption data we collected are systematic, comprehensive, and close to exhaustive. They confirmed the findings from earlier studies by other researchers that interruptions are frequent events in critical care and other healthcare settings. More importantly, our data provide the necessary time-motion information about workflow that is essential for the understanding of interruptions and the management of interruptions through informatics interventions. We have identified new categories of interruptions that show that the environmental design contributes to interruptions in workflow. The location of frequently used services outside the immediate workspace contributes to an interruption in workflow. Equipment not located in close proximity to the point of use contributes to interruption in workflow. The identification of these categories extends the study of interruptions beyond person - person and person – device interruptions. These findings indicate that the study of workflow interruptions is multi-dimensional and should include an understanding of the physical layout of the workspace and work practices in a department. We are currently using these data to analyze the workflow dynamics of ED clinicians. We plan to identify, the bottlenecks to information flow, and subsequently develop interventions which will improve the efficiency of emergency care through a tighter and more efficient management of interruptions.

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